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Evaluation of the prevalence of phenylketonuria among screened and un screened children in Baghdad

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ABSTRACT

Background: A congenital genetic condition known as phenylketonemia (PKD) is defined by a malfunction in the metabolism of the amino acid phenylalanine. Delays in diagnosis and treatment can result in mental and developmental problems, making it a serious health concern.

Objective: The purpose of the study was to compare children with PKD who were screened against those who were not in order to assess the efficacy of early screening programs.

Methodology: A descriptive analytical approach was used to collect patient data during 2021 and 2022. Data included age at diagnosis, sex, geographic distribution, developmental outcomes, and follow-up. A 95% confidence level was applied and a P value of <0.05 was used.

Results: The findings demonstrated statistically significant variations in the average age of diagnosis between screened and unscreened children, with the former having an average age of two months and the latter between 15 and 36 months. Additionally, the children who were screened at diagnosis were older (49 months) than the children who were not screened (24 and 40 months). The children who were not screened experienced issues like epilepsy, delayed walking, and mental impairment, while the majority of the screened children were female. Additionally, half of the individuals had a family history of the condition, especially among siblings, indicating a strong familial component to the illness.

Conclusion: In order to improve treatment outcomes and the quality of life for individuals with phenylketonuria, early screening is essential for minimizing developmental and mental difficulties brought on by delayed diagnosis.

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1. Introduction

PKU, or phenylketonemia, is a hereditary condition. One of the most common hereditary metabolic diseases in the world, it is more common in some populations, especially those with European ancestry. PKU is brought on by a lack of the enzyme phenylalanine hydroxylase, which causes phenylalanine to build up in the blood and other tissues, especially the brain. If this condition is not identified and treated quickly, there is a significant chance that neurological and developmental issues will arise. Seizures, behavioral abnormalities, mental retardation, and severe intellectual deficits are all directly linked to elevated blood phenylalanine levels. Since symptoms usually manifest after birth, early screening is the sole method to identify the illness before symptoms manifest, making early diagnosis of the disease essential to preventing these issues [1, 2].

Early metabolic disorder screening programs, particularly for PKU, have emerged as a key component of modern healthcare, offering the chance for early management before the disease worsens and impacts a child's mental and physical development. The gold standard for identifying the illness is high-performance liquid chromatography (HPLC) measurement of plasma amino acids. Early newborn screening programs are a powerful tool for early discovery, lowering the chance of lasting harm and allowing therapy to begin at a very young age. Nonetheless, there is still a noticeable disparity in the coverage and geographic dispersion of screening programs in both typical and distant locations. Insufficient screening programs in some places result in delayed diagnosis and unfavorable health and developmental outcomes [3, 4].

In terms of care, the mainstays of treatment include the use of phenylalanine-free amino acid supplements, newer drugs such sarpropterin, and stringent dietary adherence that necessitates lowering phenylalanine intake. To guarantee continuous adherence, patients and their families are also given psychological and educational support. There are also issues with screening program completion, community knowledge, and the capacity to follow a lifelong diet, even with notable advancements in treating early cases [5].

Given this, it is crucial to compare the results of children who had early screening with those who did not in order to assess efficacy. This is crucial for creating early detection programs, enhancing health outcomes, and making compelling arguments for the necessity of launching and growing early screening initiatives in underserved areas. Thus, by assessing the health and developmental outcomes of screened and unscreened children, as well as by looking at geographic disparities and services offered, the study seeks to assess the efficacy of early screening programs for phenylketonuria. At the Children's Hospital Center in the Baghdad Governorate, this attempts to provide a more precise knowledge of the significance of early screening and how to enhance its approach.

2. Methodology

The study adopted a descriptive and analytical approach based on clinical findings and peer-reviewed medical sources. The study was conducted at the Children's Hospital Center in Baghdad Governorate, which receives cases from the governorates of Baghdad, Anbar, Nineveh, Tikrit, and Babil, in addition to the Health Screening Center in Baghdad. This approach aimed to evaluate the accuracy and effectiveness of phenylketonuria (PKU) screening in early detection and to compare the characteristics of screened and unscreened children, focusing on clinical differences between the two groups. Data were collected from patient records during the years 2021-2022 to ensure comprehensiveness and accuracy.

2.1. Study Sample and Selection Criteria

In addition to children referred from the Health Screening Center in Baghdad or from other governorates via referral to the Children's Hospital Center, the study sample included all children diagnosed with PKU during the designated period and who received early detection screening as part of the National Newborn Screening Program.

Selection criteria included the following:

- Children with confirmed diagnosis of phenylketonuria based on plasma amino acid analysis results.

- Children with complete medical records, including medical history, test results, and treatment plan.

- Children with undiagnosed other metabolic diseases, or with incomplete records, were excluded from the study.

In order to provide sufficient representation of demographic and clinical factors, the sample was chosen non-selectively (quasi-randomly).

The number of children who underwent a medical examination was 24 children, while the number of children who did not undergo a medical examination was 1 child.

2.2 Data Collection Methods

To systematically gather fundamental patient data, a standardized questionnaire was created and authorized by the Pediatrics and Research Ethics Committee. Ten primary variables were included in the questionnaire: gender, age at diagnosis, age at treatment initiation, geographic residence, family history of phenylketonuria, formula milk availability and source, prescribed medical diet, monthly family income, compliance with health monitoring, and growth and developmental delays.

In order to guarantee the quality and responsiveness of the data collection instruments to the research goals, an ethical and research committee reviewed them before they were used. To guarantee data accuracy, information from hospital databases and medical records were consulted as primary sources.

2.3 Statistical Analysis Methods

The most recent version of IBM SPSS was used for statistical studies in order to determine statistically significant differences between the two groups and investigate the relationships between different variables.

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Calculating means, standard deviations, and frequency distributions for both continuous and categorical variables were all part of descriptive analysis.

Relationships between categorical variables were examined using statistical tests like the chi-square test, while means for continuous variables were compared using the Student's t-test. A 95% confidence level and a statistical significance level of $p<0.05$ were used.

2.4 Ethics and Approvals

The hospital's Pediatrics Committee granted ethical approval, with registration number 225366. In compliance with national and international scientific research and ethics norms, this approval included the parents' written authorization for the use of the children's medical data, as long as the information was kept private and accurate.

3. Results

The study's findings, which were organized both chronologically and by survey, showed statistically significant variations in the social and medical characteristics of children who had and did not have phenylketonuria screening. Differences between the two groups throughout the years 2021 and 2022 were made possible by a thorough examination of parameters pertaining to family history, comorbidities, and geographic location.

3.1. Social and demographic differences in 2021

The results showed that the median age at diagnosis was significantly lower among infants who underwent screening (1 month), with a range of 15 to 20 months, compared to infants who were not screened (15 months), with a range of 7 to 24 months). P = 0.044, indicating that early screening contributes to early detection.

The median current age of screened children was 49 months (range 30 to 60 months), significantly higher than that of unscreened children, which was 24 months (range 12 to 36 months). P = 0.039, indicating that screened children were significantly older than unscreened children.

No statistically significant differences were found between the two groups in terms of gender.

All children in both groups were receiving formula milk, followed a specific diet, and had a monthly income exceeding 500,000 Iraqi dinars. They attend periodic examinations and follow-ups in the hospital, as shown in (Table.1).

Table (1). Social and demographic differences in 2021

Variables	Non-screened		screened		P value
	M±S	Min-Max	M ±S	Min-Max	
Age at disease discovered	15±4	7-24	1±1.4	15-20	0.044
Current age by month	24±1.6	12-36	49±1.8	30-60	0.039
Gender	N	%	N	%	-
Male	2	25	4	28.6	0.346
Female	6	75	10	71.4	-
Family income	> 500,000 Iraqi dinars		> 500,000 Iraqi dinars		

3.2. Social and demographic differences in 2022

The results showed that the mean age at diagnosis was significantly lower for infants who underwent screening (2 months) compared to infants who were not screened (36 months), with a p-value of 0.049.

The benefits of early intervention were also demonstrated by the fact that the current age of the screened children was greater (49 months) than that of the unscreened children (40 months), with a p-value of 0.040.

There were no statistically significant differences between the two groups in terms of gender. All 12 screened children were female (100%), while the unscreened group consisted of 9 (75%) males and 3 (25%) females.

All children from both groups were receiving medical milk, following a specific diet, and had a monthly income exceeding 500,000 Iraqi dinars, and attending periodic examinations and follow-ups at the hospital. The analyses did not show significant differences in the

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social characteristics between the two groups, which reinforces that the social factors were close, as shown in (Table.2).

Table (2). Social and demographic differences in 2022

Variables	screened		Non-screened		P value
	M±S	Min-Max	M ±S	Min-Max	
Age at disease discovered	2±1.1	20-30	36±1.3	18-40	0.049
Current age by month	49±1.6	22-60	40±1.4	20-48	0.040
Gender	N	%	N	%	-
Male	-	-	3	25	-
Female	12	100	9	75	-
Family income	> 500,000 Iraqi dinars		> 500,000 Iraqi dinars		

3.3. Place of Residence

The distribution of children according to geographical location shows an important difference, as the percentage of children examined from the residents of Baghdad was 66.8%, compared to 27.2% of those not examined, while the rest of the regions (Tikrit, Anbar, Nineveh, Babil) were distributed closely, as shown in (Fig.1).

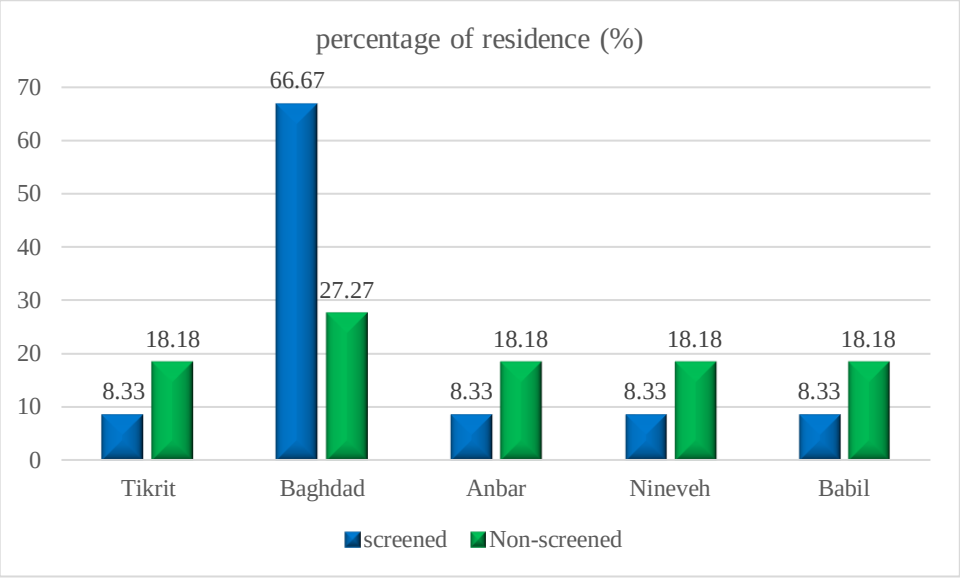

Figure (1). Place of residence for medically screened and unscreened children

3.4. Distribution of complications and medical family history

All children who did not undergo medical screening experienced complications such as stunted growth (36.4%), mental retardation (18.2%), delayed walking (36.4%), and microcephaly (9%). However, those who underwent screening had no documented complications, reflecting the importance of early detection in reducing complications. Furthermore, 50% of all children had a family history of phenylketonuria, particularly in siblings of both screened and unscreened infants. The prevalence among parents was 14% among unscreened infants and 8.3% among screened infants, as shown in (Fig.3).

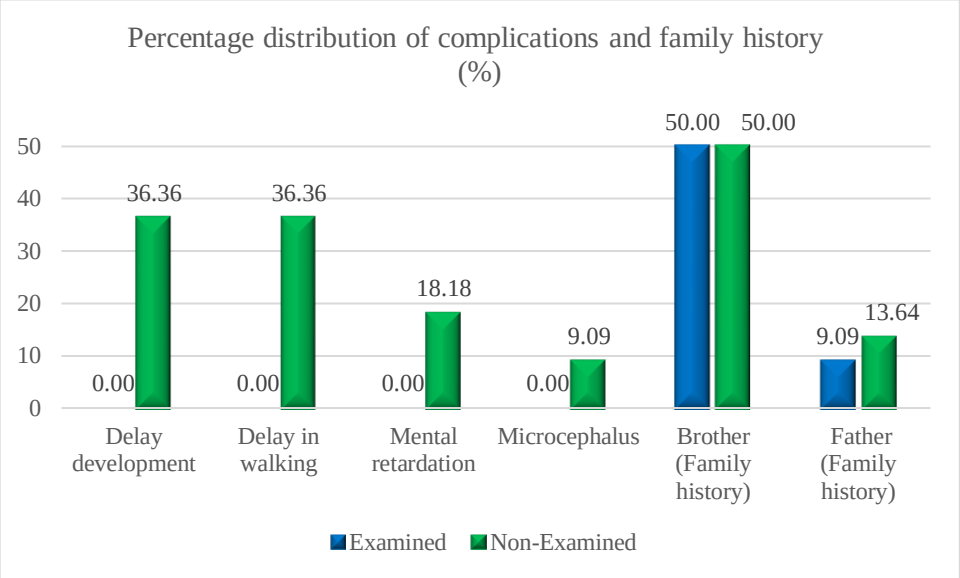

Figure (3). Distribution of complications and medical family history

4. DISCUSSION

According to the study's findings, the screened group's mean age at diagnosis was 1-2 months lower than that of the unscreened group, with a mean of 15 ± 4 months versus 36 ± 13 months, respectively. This difference was statistically significant. This is in line with the results of prior research [6], which shown that early diagnosis lowers the age at which phenylketonuria is discovered, allowing for earlier treatment commencement and better neurological and developmental outcomes [7].

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The main cause of the age difference is the ubiquitous screening programs that have been implemented recently. These programs enable early detection before symptoms manifest, so effectively preventing the development of neurological difficulties linked to phenylketonuria [8].

Furthermore, it was observed that children in the screened group were diagnosed at an older age than those in the unscreened group, underscoring the significance of early detection. This can be accomplished by enhancing therapy management and making early dietary changes, which helps lower the risk of neurological and cognitive damage [9].

It is important to note that newborn screening facilitates prompt intervention, as evidenced by earlier research showing a decreased prevalence of developmental issues in children with early diagnoses [10].

Regarding phenylketonuria's gender distribution, the study found that all screened cases in 2022 were female. However, research shows that phenylketonuria affects both sexes equally, hence this does not accurately represent the disease's overall reality [11]. Nonetheless, a greater percentage of female cases than male cases was noted, which is in line with earlier research showing that some hereditary types of PKU can occasionally be more common in females, either due to genetic factors or insufficient screening [12]. Therefore, more investigation is required to determine the causes of this aberrant distribution, possibly using genetic study of PKU-related genes.

The findings of the study also verified that the children who were the focus of screening in 2021 and 2022 showed no symptoms of developmental problems or mental impairment. This is in line with research from around the world showing that phenylketonuria and early dietary correction greatly reduce the risk of developing intellectual impairments [13].

The significance of early screening programs in preventing chronic brain damage is demonstrated by the unscreened children's group, which displayed indicators of mental impairment, small size, and growth and walking issues [14]. In terms of follow-up, the study discovered that consistent attendance at follow-up appointments undoubtedly enhanced treatment results; this conclusion is corroborated by other research [15]. Poor adherence and inconsistent follow-up, however, have been linked by some researchers to worsening neurological and cognitive disorders and endanger patient stability [16].

With a geographical and social gap between the screened and unscreened groups, the study was carried out at the Baghdad Child Center, which serves a large region that includes the governorates of Baghdad, Anbar, Nineveh, Tikrit, and Babil. In contrast to rural areas, which might not have extensive screening programs or health awareness, it was observed that the majority of cases came from metropolitan areas, which may be due to the availability of early screening and health awareness services in these locations [17].

The study's findings are in line with earlier research that demonstrated how early detection rates and, in turn, the health outcomes of impacted children are greatly impacted by the differences in healthcare access between urban and rural settings.

In order to encourage early detection, decrease the time it takes to receive diagnosis and treatment, and hence lower complications, the study's findings emphasize the necessity for future medical policies to concentrate on enhancing access to screening and awareness programs in rural areas and other Iraqi governorates.

5. Conclusion

The study's findings provide insight into the elements that influence health awareness, family history, and geographic location, as well as the vital significance of early detection of oral health issues in youngsters. The findings suggest that enhancing community education and awareness initiatives and upgrading health infrastructure are practical steps that can help raise early detection rates and lower the risk of issues associated to oral health. This lessens the financial strain on public healthcare systems while also improving the quality of life for kids. The study shows that enhancing health service delivery, particularly in areas with the highest need, and creating national preventive policies, including sustained education and awareness campaigns, are crucial steps to achieving measurable public health outcomes. Thus, these results offer scientific proof for the necessity of creating all-encompassing health policies that emphasize preventive and health promotion, which help to safeguard children's health and guarantee a safer and better society in the future.

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6. **Conflict of Interest: None.**

The authors declare that they have no conflict of interest

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